[10191/4185

METHOD FOR METERING A REAGENT INTO THE EXHAUST GAS FLOW OF AN INTERNAL COMBUSTION ENGINE

Background Information

In German Patent Application No. DE 101 39 142, a measuring device is described for ascertaining a concentration of a urea-water solution, which is applied as a reagent for an NOx adsorption catalyst in the exhaust gas flow of an internal combustion engine. From the urea-water solution ammonia is obtained which, in a regeneration phase of the NOx adsorption catalyst, brings about a reduction of nitrogen oxides. An ascertainment of the concentration of the urea-water solution is provided, whereby a precise metering of the reducing agent into the exhaust gas flow may be implemented. An indirect measuring method for ascertaining the concentration is provided, in which the vapor pressure of the urea-water solution, that is stored in a storage vessel, is measured, using a pressure sensor. The vapor pressure is created by the ammonia generated because of the hydrolysis of the urea plus the vapor pressure of the solvent water, so that because of the layout, an evaluation unit is able to ascertain the correspondingly reduced urea quantity or the urea concentration in the urea-water solution.

Also provided is a temperature sensor for registering the temperature of the urea-water solution. Using the signal of the temperature sensor, the dependence of the pressure on the temperature may be taken into consideration. The urea-water solution has a freezing point which is approximately -11 degrees C. To the extent that the previously known metering device is exposed to environmental conditions, the freezing of the urea-water solution cannot be excluded. The sudden change in density in connection with the freezing mechanically stresses the components that are filled with the urea-water solution.

An object of the present invention is to provide a method for metering a reagent into the exhaust gas flow of an internal combustion engine, which increases reliability.

Summary Of The Invention

The method according to the present invention, for metering a reagent into the exhaust gas flow of an internal combustion engine, in which the reagent is guided in

at least one component and in which a measure of the temperature of the component is recorded, provides that the measure for the temperature is compared to a predefined temperature threshold value, that the number of the threshold exceedings are counted in a counter, that the count threshold value for the number of threshold exceedings is specified, and that a service signal is made available when the count threshold value is exceeded.

The method according to the present invention makes it possible to detect a one-time, or, preferably a multiple exceeding of the temperature threshold value, and thereupon to make available the service signal. The measure for the temperature of the component similarly reflects the temperature of the reagent. The temperature threshold value is, for example, established at a value at which one property of the reagent changes. The service signal then indicates that the property of the reagent has changed once or several times. The service signal may be used as notice that, for example, the component in which the reagent is carried, or the reagent itself should be exchanged. The method according to the present invention thereby increases the reliability of metering the reagent into the exhaust gas flow of the internal combustion engine.

One embodiment provides that the temperature threshold value is equivalent to the freezing temperature of the reagent. Using this embodiment, freezing of the reagent or, for instance, a possible icing up of the component is detected by the reagent possibly contained therein.

One embodiment provides that, after the shutting down of the internal combustion engine, it is ascertained during coasting whether the component is filled with the reagent. Using this measure, the additional decisions may be made dependent on whether there is still reagent in the component after the shutting down of the internal combustion engine.

This embodiment forms the basis for the further embodiment of the present invention, according to which the counter is designed as an ice counter. The ice counter counts an exceeding of the temperature threshold value only when the component is filled with the frozen reagent. Thereby it may be reliably detected how

often the component filled with the reagent has frozen, and whether the number of freezing episodes has exceeded the counter threshold value. The service signal may be seen as a notice to test the component, and, if necessary, to exchange it.

One embodiment provides that, during the ascertainment as to whether the component is filled with the reagent, an air pressure signal is analyzed. As a function of a definite embodiment of the metering of the reagent, purging (blowing out) the reagent by compressed air may be provided. Thereby it may be ensured that, for instance, after the shutting down of the internal combustion engine, there is no longer any reagent in the component.

Another embodiment provides that, during the ascertainment as to whether the component is filled with the reagent, the operation of an emergency stop switch is taken into consideration. In general, the operation of an emergency stop switch will prevent coasting, so that one may assume that the component is filled with the reagent.

One embodiment provides that an exceeding of the temperature threshold value is counted only at the starting of the internal combustion engine. Using this measure, the point in time of counting the individual exceedings of the temperature threshold value is established exactly. To the extent that in the exceeding of the temperature threshold value an exceeding towards lower temperatures is involved, one may assume that the coldest temperature is present at the starting procedure.

One embodiment provides that the measure for the temperature of the component is obtained from the signal of at least one temperature sensor. The temperature sensor may, for instance, record the temperature of the component or the air temperature.

Brief Description Of The Drawing

The Figure shows a technical environment in which a method according to the present invention proceeds.

Detailed Description

The Figure shows an internal combustion engine 10, that has a catalytic converter 11 post-connected to it for exhaust gas purification. A metering valve 14 is provided for adding a reagent 13 into exhaust gas flow 12 of internal combustion engine 10. Reagent 13 is made available by a reagent pump 15, which obtains reagent 13 from a reagent storage tank 16. Both reagent pump 15 and metering valve 14 may be purged using compressed air that is supplied by a compressor 17.

Metering valve temperature signal 19 made available by a metering valve temperature sensor 18 that is assigned to metering valve 14, reagent pump temperature signal 21 made available by a reagent pump temperature sensor 20 that is assigned to reagent pump 15, reagent tank temperature signal 23 made available by a reagent tank temperature sensor 22 that is assigned to reagent tank 16, as well as temperature sensor signal 25 made available by a temperature sensor 24 are supplied to a temperature selection 26, which emits a temperature signal 27 to a first comparator 28.

First comparator 28 compares temperature signal 27 to a temperature threshold value 29, and, as a function of the comparison result, emits a temperature warning signal 30 both to a first AND operation 31 and to a second AND operation 32. The two AND operations 31, 32 also receive clamp-15 (terminal-15) signal 34 supplied by key switch 33. Second AND operation 32 also receives a purging error signal 36 stored by a memory 35.

A vehicle electrical system 37 is connected both to key switch 33 and a coasting control 39 via an emergency stop switch 38. Coasting control 39 is also connected to clamp-15 signal 34. Coasting control 39 emits a coasting signal 40 both to compressor 17 and to a purging detector 41. Purging detector 41, which emits purging error signal 36 to memory 35, also receives a compressed air signal 43 made available by compressed air sensor 42 that is assigned to compressor 17.

First AND operation 31 emits a freezing count signal 44 to a freezing counter 45, to which is also supplied a diagnosis signal 48 made available by a diagnosis unit 46 via a diagnosis interface 47, and which makes available a freezing counter signal 49.

Second AND operation 32 emits an ice count signal 50 to an ice counter 51, which passes on an ice counter signal 52 to a second comparator 53. Second comparator 53 compares ice counter signal 52 to a count threshold value 54 and emits a service signal 55 to a service signal memory 56, as a function of the comparison. Diagnosis signal 48 is supplied both to service signal memory 56 and to ice counter 51. Service signal memory 56 emits a switching signal 57 to a service indicator 58.

The method according to the present invention functions as follows:

Catalytic converter 11 situated in the exhaust gas flow 12 of internal combustion engine 10 cleans the at least one component of the exhaust gases of internal combustion engine 10. Catalytic converter 11 is preferably developed as an SCR (selective catalytic reduction) catalytic converter, which, in cooperation with reagent 13 renders harmless to a great extent at least one exhaust gas component, preferably NOx. Reagent 13 is, for instance, a urea-water solution, which metering valve 14 introduces into exhaust gas flow 12. In exhaust gas flow 12, or at a component not shown, ammonia is obtained from the urea-water solution, which is used as a reducing agent in the SCR catalytic converter.

Reagent 13 is accommodated in reagent tank 16, from which it is conveyed to metering valve 14 by reagent pump 15. Metering valve 14 may be designed with or without air support. In the case of an air-supported metering valve 14, the required compressed air is made available by compressor 17. The compressed air then preferably reaches metering valve 14 directly.

According to one advantageous embodiment, after the shutting down of internal combustion engine 10, purging reagent 13 is provided from metering valve 14, from reagent pump 15 and from further components not shown in greater detail. Using this measure, one may achieve that the components, such as, for instance, metering valve 14 and/or reagent pump 15 are protected after the shutting down of internal combustion engine 10. If there were longer action, it is possible that corrosion or embrittlement might occur. However, in particular, using this measure, freezing may be prevented of components 14, 15 when filled with reagent 13.

In order to record the temperature of components 14, 15, preferably at least one temperature sensor is provided. In the exemplary embodiment shown, metering valve temperature sensor 18 assigned to metering valve 14, reagent pump temperature sensor 20 assigned to reagent pump 15, reagent tank temperature sensor 22 assigned to reagent tank 16 as well as temperature sensor 24 are provided. Temperature sensor 24 preferably records the air temperature. Temperature sensor 24 may be situated, for example, in an intake region of internal combustion engine 10 that is not shown in greater detail, or in an air conditioner that is also not shown, provided internal combustion engine 10 is situated in a motor vehicle.

The at least one temperature sensor 18, 20, 22, 24 preferably records a measure for the temperature of the most sensitive component 14, 15. The measure for the temperature of component 14, 15 is similarly a measure for the temperature of reagent 13. Temperature signals 19, 21, 23, 25 made available by temperature sensors 18, 20, 22, 24 are supplied to temperature selection 26, which passes on one of temperature signals 19, 21, 23, 25 as temperature signal 27 to first comparator 28. The first comparator emits temperature warning signal 30 via temperature signal 27, in response to each exceeding or undershooting of temperature threshold value 29. Temperature selection 26 may pass on, for example, the highest or the lowest temperature as temperature signal 27. If necessary, a particular selection may be fixed.

Using the measure provided according to the present invention, each undershooting or exceeding of temperature threshold value 29 by temperature signal 27 may be counted, and, upon the exceeding of count threshold value 54, service signal 55 may be issued. Temperature signals 19, 21, 23, 25 especially make possible the detection of freezing of at least one component 14, 15, that is filled with reagent 13. The freezing point of a urea-water solution that may be provided as reagent 13 is at least approximately around -11 degrees C. This temperature may easily be reached or undershot in wintertime. We next look only at such an undershooting of the freezing point of reagent 13.

Freezing counter 45 counts each appearance of freezing count signal 44, which appears in response to each appearance of temperature warning signal 30, provided the AND condition in first AND operation 31 is satisfied. The AND condition designates that, simultaneously with the appearance of temperature warning signal 30, clamp-15 signal 34 has to be present, which key switch 33 makes available. The clamp-15 signal means that an operating person has operated key switch 33 for starting internal combustion engine 10, and that key switch 33 is connected to vehicle electrical supply 37 for the energy supply of the entire installation, via emergency stop switch 38. Using this measure, it is achieved that freezing count signal 44 is able to appear at first AND operation 31 only after the starting of internal combustion engine 10. Freezing counter 45 counts the appearance of freezing count signal 44 and emits freezing counter signal 49. Freezing counter signal 49 may, for instance, be compared to a predefined boundary value, a specified measure being able to be taken if the boundary value is exceeded.

For example, freezing counter signal 49 may remain stored in freezing counter 45, and be read out for diagnosis purposes by a diagnosis unit 46 that may, perhaps, be connected via diagnosis interface 47. Furthermore, freezing counter 45 may be canceled using diagnosis signal 48.

Of special advantage is the measure that temperature warning signal 30 is counted only if component 14, 15 is filled with reagent 13, so that, upon the appearance of temperature warning signal 30, one may assume icing up of component 14, 15. Because of the sudden change in density of reagent 13, that appears in response to icing up, component 14, 15 may be damaged.

Inasmuch as even a one-time freezing up of components 14, 15 is critical, count threshold value 54 may be set to the number one. That means that each individual exceeding of count threshold value 54 leads to the appearance of service signal 45. In test series it was determined that, in practice, more than one icing up, for example, 50 icing up occurrences may be gotten through before a breakdown must be expected. Metering valve 14 has proven to be especially at risk. Similarly, it has been shown that it is sufficient to draw upon reagent pump temperature signal 21,

supplied by reagent pump temperature sensor 20, as a measure for the temperature of metering valve 14 or reagent 13 in metering valve 14.

Since it may be assumed that, during the operation of internal combustion engine 10, freezing of reagent 13 does not occur by heating at least one of component 14, 15 or reagent 13 directly, one may assume that freezing of component 14, 15 occurs only in the shut-down state of internal combustion engine 10.

It is therefore advantageously determined whether component 14, 15 is filled with reagent 13 in the shut down state of internal combustion engine 10. According to a first exemplary embodiment, compressed air signal 43 is evaluated for this. After the operation of key switch 33 for shutting down internal combustion engine 10, coasting control 39 still activates compressor 17, using coasting signal 40, for a specified time, in which component 14, 15 is flushed by the compressed air and reagent 13 is purged.

First of all, the case may occur that, during coasting time, the air pressure is not sufficient, or no compressed air at all is available. This state is recorded by compressed air sensor 42, which may be assigned, for example, to compressor 17. Purge detector 40 determines, with the aid of compressed air signal 43, that an error has occurred, and emits purge error signal 36 to memory 35. Memory 35 has the task of storing purge error signal 36 until the next operation of key switch 33.

According to another exemplary embodiment, the operation of emergency stop switch 38 is taken into consideration. Emergency stop switch 38 completely separates, from vehicle electrical supply 37, not only key switch 33 but also coasting control 39, so that purging of components 14, 15 using compressed air cannot take place. This state may be determined in purge detector 40 with the aid of coasting signal 40 and clamp-15 signal 34. If no coasting signal 40 appears when clamp-15 signal 34 is present, purge error signal 36 is emitted to memory 35.

In response to the satisfied AND condition, second AND operation 32 emits ice count signal 50 to ice counter 51. Ice counter signal 52 supplied by ice counter 51 is compared by second comparator 53 to count threshold value 54. When count

threshold value 54 is exceeded, service signal 55 is made available and stored in service signal memory 56. At the same time, service indicator 58 is able to be activated by switching signal 57.

Stored service signal 55 may be read out during a diagnosis by diagnosis unit 46 using diagnosis signal 48. At the same time, stored service signal 55 as well as ice counter 51 may be canceled using diagnosis signal 48, and service indicator 58 may be reset. In this connection, the appearance of service signal 55 gives notice that component 14, 15 should be tested based on the exceeding of the specified number of freezing occurrences and exchanged if necessary.